TWO NEW PARASITES OF THE TARNISHED PLANT BUG IN ONTARIO: *LEIOPHRON PSEUDOPALLIPES* AND *EUPHORIANA LYGIVORA* (HYMENOPTERA: BRACONIDAE, EUPHORINAE)

C. C. Loan

Research Institute, Canada Department of Agriculture, Belleville, Ontario

Abstract

Leiophron pseudopallipes new species and *Euphoriana lygivora* new species, parasites of *Lygus lineolaris* (P. de B.) in Ontario, are described. The former parasite species is associated with *L. lineolaris* breeding on wild composites and other weeds; the latter with *L. lineolaris* on *Solidago canadensis* L. Populations of *pseudopallipes* are separated from *Leiophron pallipes* Curtis by differences in field biology and characters of the antenna, male genitalia, and wing venation.

Introduction

Among the complex of insects parasitic on *Lygus lineolaris* (P. de B.) in North America is the Holarctic braconid *Leiophron pallipes* Curtis (Clancy and Pierce, 1966). The life cycle of *pallipes* in Ontario differs from that known for other species of *Leiophron* by the occurrence of two discrete populations of immature stages and adults (Loan, 1965). These temporally-separated populations are composed of separate species, and those braconids constituting the later population (August and September, chiefly) are here described as *pseudopallipes*. It is, apparently, the species introduced into California from New Jersey for *Lygus* control (Clancy and Pierce, 1966; M. H. Brunson, *in litt.*), and whose host plant preference was investigated by Streams *et al* (1968) in Connecticut. The earlier population, flying in eastern Canada chiefly in May and June is *pallipes* Curtis and differs from *pseudopallipes* by phenological and morphological characters.

Lygus lineolaris is also parasitized by *Euphoriana uniformis* Gahan in the northeastern United States and the discovery of this braconid in Ontario was expected. However, a new species *E. lygivora* was associated with this mirid from rearings in the Belleville, Ontario, district.

L. pallipes is the commonest *Leiophron* species in the Canadian National Collection and in the United States National Museum. It is widely distributed and easily collected from grasses and forage legumes in early summer. Various hosts are recorded for *pallipes* in Europe (Brindley, 1939) and North America (Arrand and McMahon in Craig, 1963; Loan, 1965). However, Arrand and McMahon's records of *Chlamydatus* sp. and *Plagiognathus medicagus* Arrand in Saskatchewan are erroneous as the reared parasite is not *pallipes* (unpublished data).

The synonyms of *pallipes in* North America are *Microctonus punctatus* Provancher and *Euphorus mellipes* Cresson and, in Europe, *Microctonus barbiger* Wesmael (Muesbeck, 1936). The types of *punctatus* and *mellipes* were examined to determine if either is the type of the sibling population of *pallipes*. That of *mellipes* is badly damaged (gaster missing, antenna broken); the head of the lectotype of *punctatus* is missing. The evidence from either type is obviously inadequate and in any case a large type series is needed to assess the variation. These do not exist, and it seems best to retain the present Nearctic synonymy of *pallipes*, and provide a new name for the sibling population. The description

of *barbiger* refers to specimens with antennal segments of up to 30. This number, however, is out of the range of *pallipes* (maximum 27) and suggests that *barbiger* may include several species. This problem, and the possible Palearctic occurrence of *pseudopallipes* require investigation.

Types and paratypes of the new species will be deposited in the Canadian National Collection (CNC) and other paratypes of *pseudopallipes* only, in the collections of the United States National Museum and of the University of Connecticut.

Leiophron pseudopallipes, New Species

Holotype — Female (CNC11587) Fuller, Ontario, Canada, latitude 44° 24'N, longitude 77° 25'W, reared August 3, 1967, from nymphs of *Lygus lineolaris* collected September 4, 1966, feeding on *Solidago canadensis* L., C. C. Loan.

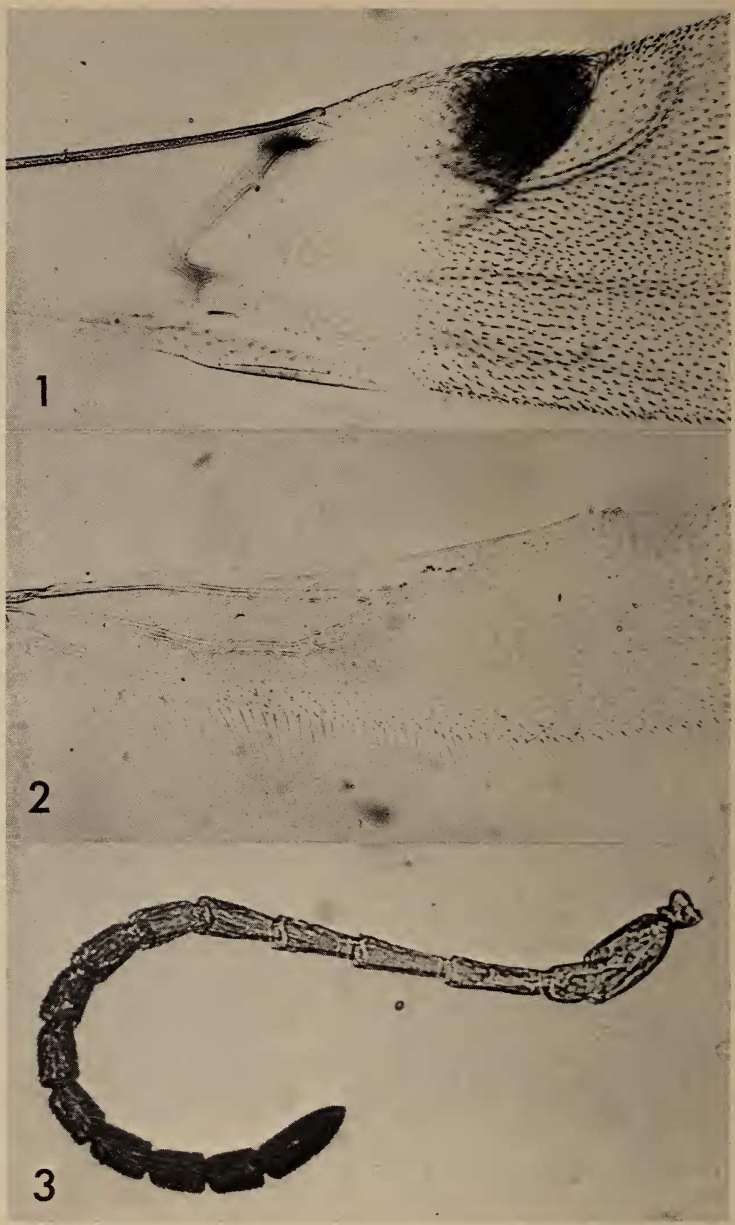
Length 3.0 mm. Dark reddish brown: scape, blade of mandible except apex light yellow; clypeus, pedicel, basal segments 1-3 of flagellum, fore and midlegs light brownish yellow, not as pale as scape; segments 4-19 of flagellum dusky; tibia of hind legs light dusky; gaster behind tergite 1 light reddish brown.

Head rectangular, wider than thorax (29:22), 2.0 times as wide as deep from eye to basal articulation of mandible; lower face from antennal sockets to base of clypeus slightly longer than wide, shagreened between eyes, dull, covered with appressed, white hair in side view; malar space not as long as basal width of mandible (2:3), 2.0 times as long as pedicel and subequally as long as segment 3 of flagellum; antenna 21-segmented, flagellum 3.4 times as long as width of head at vertex, 2.0 times as long as hind tibia; segment 1 of flagellum about as long as scape and pedicel together, longer than segment 2 (14:9) and 3 (14:8); apical segment more than 2.0 times as long as penultimate segment, not quite as wide; eye almost as wide as face between eyes (10:11), only slightly wider than temple (10:9), 1.6 times as long as wide; frons of upper face medially carinate, depressed near antennal sockets, completely punctulate, finely hairy; OOL not quite as long as POL; space from median to lateral ocellus 0.6 times as long as OOL; vertex shiny, weakly punctate; occipital carina complete.

Scutum of mesonotum covered with fine hair, indistinctly sculptured by shallow, oblong depressions; lateral lobes shiny, relatively smooth, mostly glabrous except thinly hairy next to scutum; foveae of prescutal sutures carinate, wide, rather deep; mesepisternum rugulose, partly smooth anterolaterally; fore wing 0.8 times as long as body excluding antenna; stigma 2.4 times as long as broad; first abscissa of radius short, almost punctiform, perpendicular: radial cell at wing margin slightly more that 0.3 times as long as stigma; nervellus and basal abscissa of basella subequal, not quite as long as apical abscissa; hind tibia 1.4 times as long as hind femur, almost as long as gaster behind tergite I(35:36); propodeum uniformly, closely rugulo-reticulate, slightly wider than long (7:6), posterior face somewhat flat, not excavated.

Gaster slightly more than 0.5 times as long as head, thorax and propodeum together; tergite 1 rugulo-striate with some medial reticulae, 1.5 times as long as wide at apex.

Allotype — Male, data as cited for female holotype except reared July 29, 1965. Similar facies as holotype. Antenna 24 segments, flagellum longer, robust basally diminishing in width apically; segment 1 of flagellum only slightly longer than 2 (6:5).



FIGURES 1 to 3. *Euphoriana lygivora*. 1. fore wing; 2. hind wing; 3. antenna (left side, paratype female).

Paratypes — 79 females, 93 males, with data listed below.

Locality records — The type series includes material chiefly from northeastern North America with one record from Ohio and one from Georgia. Material from the western provinces is excluded because of close resemblance between *pseudopallipes* and *pallipes,* because of lack of reared material, and because little or no field data are associated with specimens. Much of it is

probably *pallipes* judging by dates of capture which are chiefly in June and July. Regional variation was apparent, for example, the size of the phallus of British Columbia material is intermediate between eastern *pallipes* and *pseudopallipes,* and the median number of flagellar segments is like that of *pseudopallipes.* Rearings and host data are needed to determine the basis of the variation.

CANADA: **Quebec:** One female, Lac Brûlé, July 21, 1947, O. Peck; one female, Cascapédia, August 3, 1954, J. E. H. Martin; one male, Mistassini, August 3, 1956, J. R. McGillis. **Ontario:** one female, Strathroy, July 21, 1924, H. F. Hudson; one male, Ottawa, August 3, 1947, W. R. M. Mason; one female, Bells Corners, July 20, 1941, G. S. Walley; one male, Ottawa, July 25, 1951, J. E. H. Martin; one male, one female, Marmora, August 15, 1952, C. Boyle; one male, one female, Brighton, July 21, 1954, J. C. Martin. The following were swept, or reared from *Lygus lineolaris* collected at or near the type locality: two males, 13 females, September 2, 1962, swept from *Chenopodium alba* L.; 23 males, three females, August 3 to 6, 1963, swept from *Solidago canadensis;* two females, July 25 to 26, 1964, swept from roadside composites; three males, eight females reared July 29 to August 7, 1965; two males reared July 23 to 27, 1966; two males, three females reared August 4 to 8, 1967, C. C. Loan. UNITED STATES: *Connecticut:* two females, E. Hartford, August 20, 1947, Howard E. Evans; 44 males, 15 females, Storrs, July 9 to August 12, 1969, F. Streams. **Georgia:** one female, Hiawasee, August 19, 1957, L. A. Kelton. **New Jersey:** three females, Moorestown, July 26, 1963, swept in weedy field, F. Streams; two males, five females, 1963 (no other data); four males, six females Burl County, August, 1964. **New York:** two females, Ithaca, August 10, 1947; two females, Slaterville, August 25, 1951, C. Dasch. **Ohio:** one male, Steubenville, September 4, 1950, J. C. Martin; one female, August 17, 1951, C. Dasch.

Remarks

Specimens of *pseudopallipes* and of *pallipes* are so alike that, except for the maximum number of antennal segments, Muesebeck's (1936) diagnosis of *pallipes* covers the two species. Antennal characters, wing venation, and male genitalia are characters enabling separation of populations of the two species. No doubt there are others, though the ratios between various landmarks of the head, between the combined pedicel and scape and basal flagellar segments 1-3, between the malar space and flagellar segment 3 and between the length and apical width of tergite 1 of the gaster appeared similar. Characters counted, or measured (values in mm) with differences between means significant at the 5% level are as follows:

	pseudopallipes			*pallipes*		
	N	Mean	SE	N	Mean	SE
Parameres of						
phallus length	25	0.204	0.0020	25	0.183	0.0020
basal width	25	0.183	0.0034	25	0.162	0.0038
Stigma						
length	46	0.461	0.0043	49	0.499	0.0074
Nervellus						
length	27	0.120	0.0021	44	0.30	0.0026
Basella length of						
basal abscissa	29	0.133	0.0024	45	0.148	0.0023
apical abscissa	29	0.155	0.0029	44	0.167	0.0025
Flagellum						
length	31	2.26	0.0314	20	2.41	0.0441
	36	1.84	0.0258	28	2.05	0.0299
no. segments	25	22.00	0.0577	25	23.12	0.1779
	25	19.12	0.1224	25	21.12	0.1868

These data show that the parameres of the phallus of *pallipes* are neither as long nor as wide basally as the parameres of *pseudopallipes*. This difference is not related to body length as the difference between the means of the length of the first posterior tarsal segment was not significant. Each of the wing characters listed is longer in *pallipes*. However, neither the length of the radial cell, a good taxonomic character in the *Leiophron* group, nor the width of the stigma differed significantly. The antenna of *pallipes* is longer with 1 or 2 more segments than that of *pseudopallipes*. It should be noted that in this evaluation, the apical segment of the flagellum was considered to be 1 segment only, even if it was 2.0 times or more as long as the penultimate segment and showed a suggestion of segmentation. Frequency distributions of the number of flagellar segments of each species are as follows:

		No. of flagellar segments								
		17	18	19	20	21	22	23	24	25
♂	*pseudopallipes*					21	45	15	1	
	pallipes					1	10	39	43	10
♀	*pseudopallipes*	2	7	31	21	3	1			
	pallipes			6	25	49	19	2		

Biology

L. pseudopallipes was reared from two *Lygus* species in the Belleville district: *lineolaris,* breeding on weeds *(Chenopodium, Amaranthus)* and wild composites *(Solidago, Aster, Erigeron, Eupatorium)*; and *vanduzeei* Knight, a monophagous, univoltine mirid found on *Solidago*. The phenology and incidence of *pseudopallipes* parasitic in *lineolaris* breeding on *Chenopodium* has been reported (as *pallipes,* Loan, 1965). Populations of immature parasites were found in early August and September on *Solidago* in 1963, 1964, 1968 and 1969, and on weeds and other composites in 1963 and 1964. The incidence of parasitism of the *Lygus* hosts on *Solidago* in the Belleville district has varied from 0 to 12 parasites per 100 nymphs. These values may include larvae of *Euphoriana lygivora* which was not separable until 1969. Final instar larvae of *pseudopallipes* emerged from nymphs, and those of *pallipes* from teneral adults of *L. lineolaris*. Cocoons are formed in soil debris near the breeding plant of the host mirids. The diapausing adults overwinter in cocoons and are widely distributed since *Solidago* and *Aster,* especially, are common herbs interspersed between areas of cultivation.

The time of emergence of adults from overwintered cocoons is probably the most important factor isolating *pseudopallipes* from *pallipes*. In the insectary, in 1965, 3 adults of *pseudopallipes* emerged July 29; 6, August 1 to 3; 2, August 7; in 1966, 1, July 27; in 1967, 3, August 4; and 2, August 8. The number of emergents is low because of mortality of adults in cocoons. A possible reason for this may be insufficient moisture in the insectary after spinning up.

Though larvae of *pallipes* emerge from various mirids infesting legumes and grasses in a four-week period in June and early July, adults emerged in the insectary at about the same time in May: 3 adults, May 6; 5, May 9 to 12, 1966; 1, May 2; 3, May 14, 1967 (*Leptopterna dolobrata* (L.); 11, May 6 to 12, 1966 *(Adelphocoris lineolatus* (Goeze)); 1, May 14; 4, May 16 to 18; 3, May 22, 1966; and 3, May 10, 1967 *(Lygus lineolaris).* Given adequate numbers, it is possible that differences related to larval emergence times might be evident. The data show, however, a separation in times of emergence between *pallipes* developing in first generation *L. lineolaris* and other mirids in May and June and *pseudopallipes* developing in second generation *lineolaris,* and *vanduzeei* in August and September.

Discussion

L. pseudopallipes was not previously recognized as a sibling species of *pallipes* because of morphological similarities, because much of the museum material is *pallipes,* collected in early summer, and because no biological information was available. The new taxon is ranked as a species because it is reproductively isolated from *pallipes* by phenological differences. If there were an overlap of adults, host and host plant preferences and the larger phallus of *pseudopallipes* might prevent interbreeding. Among the known *Leiophron* species, *pallipes* is the most plastic by its polyphagous parasitism and adaptation to different ecosystems (grass, forage legumes). The genesis of *pseudopallipes* from *pallipes,* or *vice versa* would require, primarily, a change in diapause period to adjust to the seasonal occurrence of mirid nymphs.

Euphoriana lygivora, New Species

Holotype — Female (CNC11588) Fuller, Ontario, Canada, latitude 44° 24'N, longitude 77° 25'W, reared August 14, 1969, from nymphs of *Lygus lineolaris,* collected August 21 to September 6, 1968 feeding on *Solidago canadensis,* C. C. Loan.

Length 2.7 mm. Reddish yellow; flagellar segments 1-4, bases of 5, 6 pale yellow, remainder dusky; frons immediately anterior to each ocellus dark reddish; propodeum dark brown; apical 0.2 of gaster behind tergite 1 light reddish; hind tibia except basal 0.3 light dusky.

Head nearly quadrate, slightly wider than long (22:19); vertex, cheeks, smooth, highly polished, glabrous; frons lightly shagreened; face shagreened, with short, thick pubescence; hair of clypeus sparse, erect, nearly as long as flagellar segment 1; frons unusually long, 1.3 times longer than face between antennal sockets and base of clypeus, level and flat 0.5 times its length behind antennal sockets then declivous to median ocellus; face flat, nearly vertical, eyes directed forward; antenna 15 segments (apical considered 1 segment); flagellum almost 2.0 times as long as width of head at eyes (20:11), as long as thorax and propodeum together; scape as long as segment 2 of flagellum; segment 1 of flagellum not as long as scape and pedicel combined (19:13), slightly longer than segment 2 (10:9) and 3 (10:8); apical segment more than 2.0 times as long as penultimate segment of flagellum, wider than segment 1 (4:3); lower face between eyes wider than long (4:3), as wide as frons is long; malar space 0.5 times as long as basal width of mandible, as long as pedicel, less than 0.5 times as long as flagellar segment 1; eye 1.4 times as long as wide; temple as wide as face between eyes, almost as wide as eye (8:9); POL not as long as OOL (2:3), slightly longer than space from median to lateral ocellus; vertex from occipital carina to lateral ocellus nearly as long as face between antennal sockets and base of clypeus, somewhat longer than OOL (11:9); anterior margin of median ocellus in line with posterior margin of eye.

Thorax not as wide as head (8:11); mesonotum generally glabrous, prescutal sutures indicated only by linear, shagreened areas converging posteriorly, area of convergence as wide as scutellar groove which is divided by 5 carinae; scutum punctulate medially; lateral lobes smooth, polished; scutellum rugulose; mesepisternum rugulo-aciculate posteroventrally, smooth and polished anterodorsally; hind tibia subequal to length of gaster behind tergite 1, longer than hind femur (28:23); propodeum almost as wide as long (9:10), rugulo-reticulate, sloping slightly behind, posterior face flat, nearly vertical; fore wing almost as long as body not including antenna and gaster behind tergite 1; radial cell very short, 0.25 times as long as stigma; first abscissa of radius punctiform; stigma 2.3 times as

long on wing margin as broad, base broadly hyaline; hind wing about as wide as fore wing; apical abscissa of basella much shorter than basal (7:12); nervellus not as long as marginal cilia. Gaster behind tergite 1 polished, glabrous except sparsely hairy at apex; tergite 1 subequally as long as propodeum, 3.0 times as long as wide at apical margin, apex slightly wider than base, laterally striate and medially somewhat rugulo-reticulate.

Paratype — One female swept Wallbridge, Ontario, latitude 44° 13'N, longitude 77° 30'W, August 18, 1969, from *Solidago canadensis,* C. C. Loan.

Remarks

E. lygivora runs to *uniformis* Gahan in the key to Nearctic species of *Euphoriana* (Loan, in press) by its completely obliterated cubitus. The following couplet summarizes the important differences between them.

Head immargined behind; eye not as wide as temple (5:7); malar space almost as long as basal width of mandible (5:6); mesonotum uniformly smooth, scutum and lobes not differentiated; propodeum reddish yellow, rugulose ..... *uniformis* Gahan.

Head distinctly margined behind; eye as wide as or wider than temple; malar space 2.0 times as long as basal width of mandible; scutum of mesonotum shagreened posteriorly, differentiated by lightly impressed prescutal sutures; propodeum dark brown, rugulo-reticulate ..... *lygivora* n. sp.

Biology

Braconid larvae were reared from nymphs of *L. lineolaris* swept from *Solidago* on August 18 to 21 and September 5 to 9, 1968. The cocoons were overwintered and a single specimen of *E. lygivora* emerged August 6, 1969. A second specimen was obtained August 18, 1969, sweeping *Solidago.* This specimen was the only one captured in about 12 hours of sweeping from August 10 to 26.

Acknowledgments

Help and material are gratefully acknowledged from W. R. M. Mason (Entomology Research Institute, Canada Department of Agriculture, Ottawa); C. F. W. Muesebeck and Paul Marsh (Smithsonian Institute and United States Department of Agriculture, respectively, Washington); F. A. Streams (University of Connecticut, Storrs); M. F. Brunson (United States Department of Agriculture, Moorestown) and C. H. Craig (Research Station, Canada Department of Agriculture, Saskatoon, Saskatchewan). The author also thanks Réné Béique (University of Laval, Quebec) and N. Roback (Academy of Natural Sciences, Philadelphia) for the loan of types; and A. Neboiss (National Museum of Victoria, Melbourne) for information on the *pallipes* lectotype; and L. A. Kelton (Entomology Research Institute, Canada Department of Agriculture, Ottawa) for determination of Miridae. Statistical help from Diether Peschken and B. C. Smith (Research Institute, Canada Department of Agriculture, Belleville) is acknowledged.

References

Brindley, M. D. A. 1939. Observations on the life history of *Leiophron pallipes* (Curtis) (Hymenoptera: Bracondiae) a parasite of Hemiptera - Heteroptera. Proc. Roy. Entomol. Soc. (London) (A) 14: 51-56.

Clancy, D. W., and H. D. Pierce. 1966. Natural enemies of some lygus bugs. J. Econ. Entomol. 59: 853-858.

Craig, C. H. 1963. The alfalfa plant bug, *Adelphocoris lineolatus* (Goeze) in northern Saskatchewan. Can. Entomol. 95: 6-13.

Loan, C. C. 1965. Life cycle and development of *Leiophron pallipes* (Curtis) (Hymenoptera: Braconidae, Euphorinae) in five mirid hosts in the Belleville district. Proc. Entomol. Soc. Ont. 95: 115-121.

Loan, C. C. *Euphoriana* Gahan: a redefinition with new name combinations and a new Canadian species. Proc. Entomol. Soc. Washington. *In press.*

Muesebeck, C. F. W. 1936. The genera of parasitic wasps of the braconid sub family Euphorinae with a review of the Nearctic species. U.S. Dept. Agr. Misc. Pub. 241, 36 p.

Streams, F. A., M. Shahjaham, and H. G. Lemasurier. 1968. Influence of plants on the parasitization of the tarnished plant bug by *Leiophron pallipes*. J. Econ. Entomol. 61: 996-999.

INTRINSIC FACTORS CAUSING QUALITATIVE CHANGES IN POPULATIONS OF THE GYPSY MOTH

David E. Leonard*

Department of Entomology, The Connecticut Agricultural Experiment Station, New Haven

Abstract

A change in the quality of individuals of the gypsy moth can be induced by several intrinsic and extrinsic factors. This change is expressed by a prolongation of instar I, an increase in larval activity during instar I, and an increase in the number of larval instars. The lag in development at instar I is associated with a longer prefeeding phase during which larvae are more active. These active larvae are more readily dispersed by wind. The behavioral shift can be induced during instar I by crowding, starvation, or cool temperature, or in the maternal generation by factors affecting the size of eggs. The most important effect of the qualitative change on the population biology of the gypsy moth is that it provides a mechanism for numerical self-regulation that operates rapidly to changes in population density, and is more efficient than if dependent solely on selection for expression. A new approach to control by prevention of the qualitative change is suggested, whereby populations would be maintained at sparse levels where suitable host plants prevail to suppress outbreaks and subsequent widespread dispersal of larvae.

Introduction

The work of Wellington (1957, 1960, 1962, 1965) on the western tent caterpillar, *Malacosoma pluviale* (Dyar), and of Chitty (1960) on the vole,

*Present address: Department of Entomology, University of Maine, Orono